# WATER QUALITY AND BATHYMETRY OF SAND LAKE, ANCHORAGE, ALASKA

By Donald E. Donaldson

Sand lake is the deepest lake in the lowlands of Anchorage. It is underlain by deltaic sands and gravels (Schmoll and Dobrovolny, 1972). Sand Lake has no observable surface inlet or outlet. Short-term water-level changes are controlled primarily by precipitation, surface runoff from the surrounding residential area, and evaporation. Long-term changes reflect the regional ground-water level, which in turn may be affected by urban-development practices within the lake basin. However, at this time not enough is known of the hydrology to define precisely the origin of the lake water or the amount and direction of subsurface drainage (Zenone, 1976).

During the past 10 years, urban growth has accelerated in Anchorage. The Sand Lake area exemplifies this growth trend; its population has more than tripled since 1963. In 1973, 36 private dwellings lined the shore and approximately 200 homes were within one-quarter mile of the lake. During 1974 and 1975, housing density increased further; Sand Lake has become an urban lake.

As urban development and human activities increase, water resources of an area may be adversely affected unless sound water-resource management practices are instituted (Hasler, 1969; Britton, Averett, and Ferreira, 1975). One form of lake degradation is eutrophication, the natural or artificial enrichment of lake waters by nutrients required by plants; plant growth consequently proliferates, tending to hasten the extinction of a lake (Beeton, 1970). Natural eutrophication is a long-term process, measured in geologic time. However, cultural eutrophication may be much faster and is a major problem in water-resource management (Fruh and others, 1966).

Nutrition of plants in a lake depends on the amounts of certain elements present and their interaction. Phosphorus, nitrogen, iron, and silica are generally accepted as important nutrients promoting plant growth (Britton, Averett, and Ferreira, 1975; Lee, 1970). Bartsch (1972) has reported that increases of phosphorus frequently lead to accelerated eutrophication. One major source of phosphorus and nitrogen is urban runoff (Lee, 1970; Hasler, 1969).

## PURPOSE AND SCOPE

A study of Sand Lake was undertaken by the U.S. Geological Survey and the Greater Anchorage Area Borough (now part of the Municipality of Anchorage) to define the water quality and provide a starting point for urban water-resource management.

This report summarizes water-quality and bathymetric information collected by the Geological Survey between 1967 and 1975. This information is intended for use by environmental planning departments, developers, and others interested in or responsible for the management of urban water resources.

## DATA COLLECTION AND ANALYSIS

Between 1967 and 1975 miscellaneous water-quality samples were collected from Sand Lake. The 1968 samples are grab samples collected close to the south shore of the lake near site 2. In 1972 three sample sites were chosen; from these sites, samples were collected at selected depths in March, June, and August. The 1974 sample was taken at a point near the middle of the lake (near site 2) and 3 ft (1 m) below the ice. The 1975 samples were integrated with depth (from top to bottom) and came from the east end of the lake (near site 1). In 1974 and 1975 additional water-quality data were acquired, including samples of snowmelt water collected from street gutters during spring breakup periods in the Brentwood subdivision.

The chemical analytical methods and techniques used in this study are described in Rainwater and Thatcher (1960), Brown, Skougstad, and Fishman (1970), and Slack, Averett, Greeson, and Lipscomb (1973).

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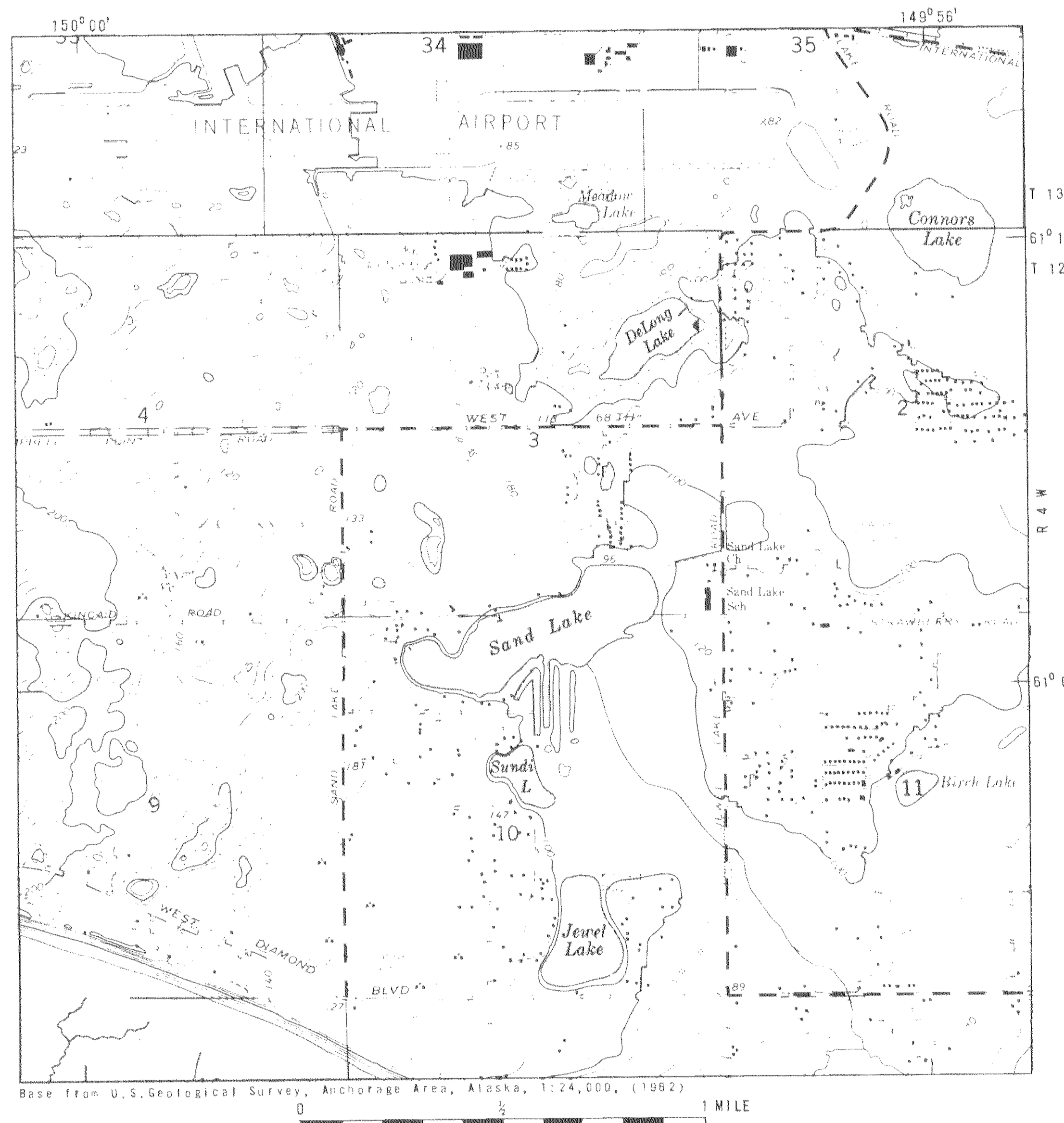
## CONVERSION FACTORS

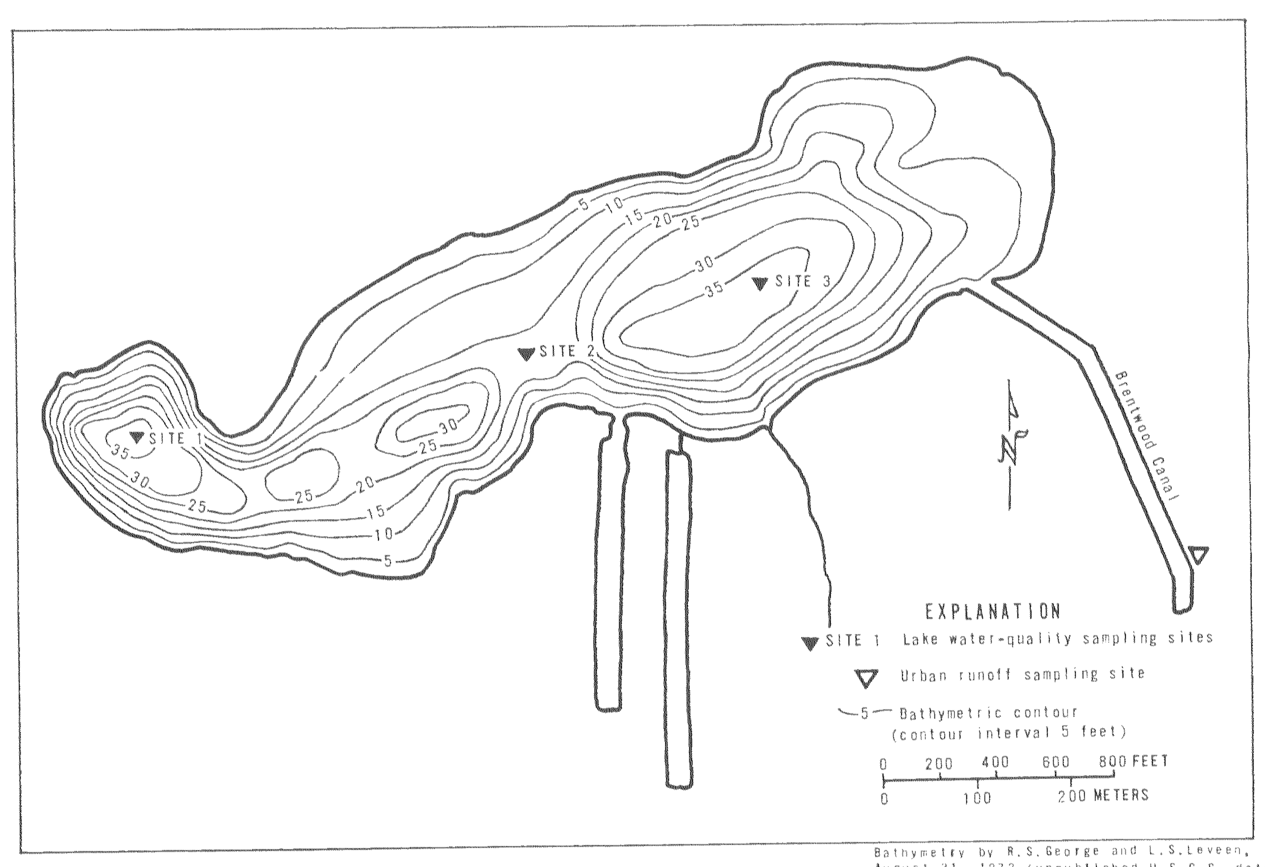
For those readers who may prefer to use metric units rather than English units, the conversion factors for the terms used in this report are listed below.

| Multiply English units | By | To obtain metric units |
|---|---|---|
| feet (ft) | 0.3048 | meters (m) |
| miles (mi) | 1.609 | kilometers (km) |

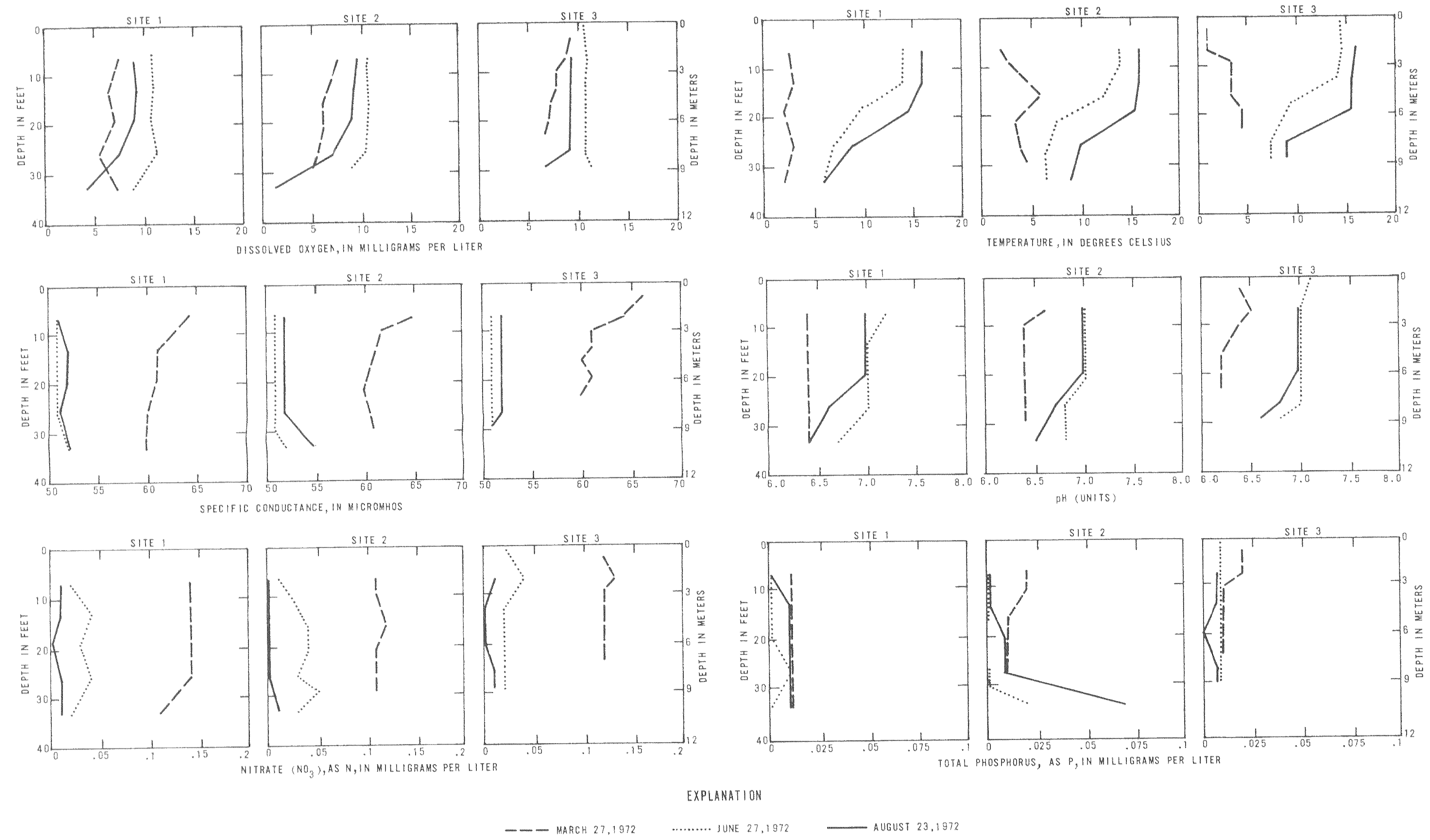
Vertical aerial photograph showing the extent of urbanization around Sand Lake in June 1975. PHOTO BY NORTH PACIFIC AERIAL SURVEYS, INC.




Sand Lake and vicinity, Anchorage, Alaska.




Bathymetry of Sand Lake.



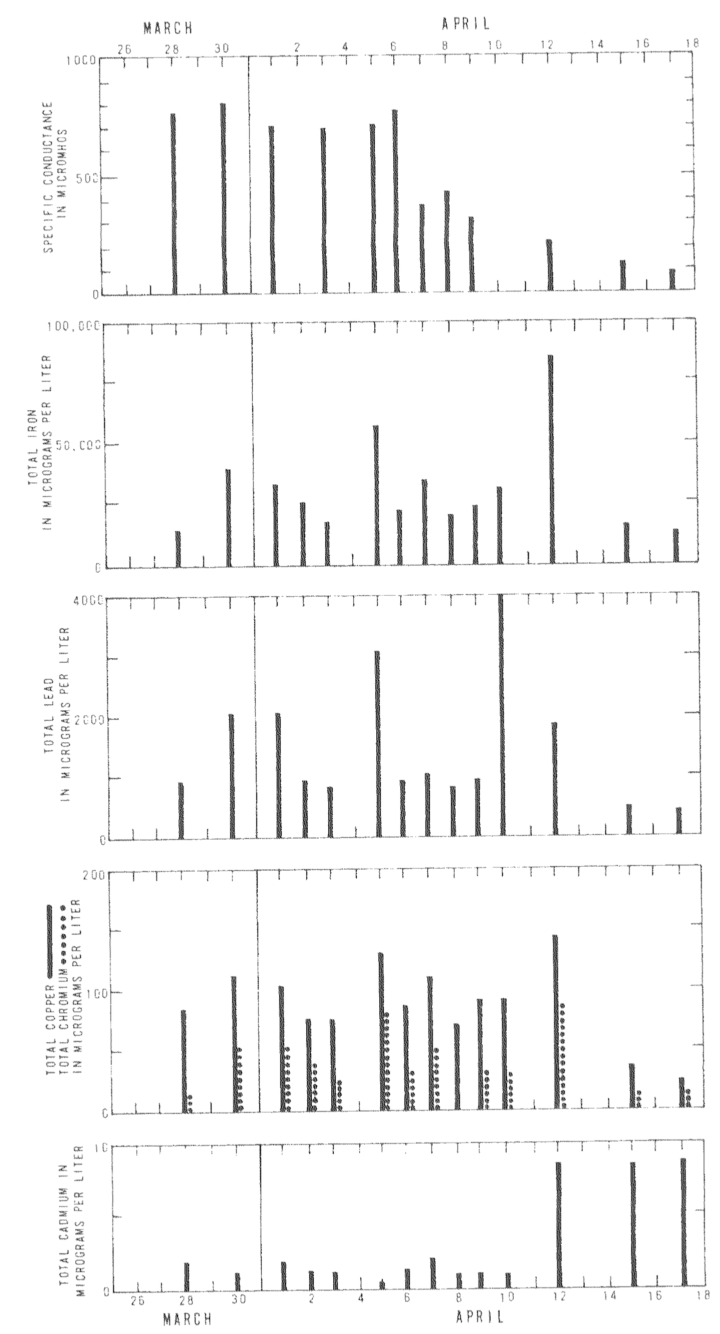

Profiles of Selected Water-Quality Parameters, 1972

Seasonal profiles show that Sand Lake is dimictic, that is, the water turns over twice each year. The data indicate, further, that the lake is oligotrophic, that is, having low concentrations of nutrients (nitrogen and phosphorus) and dissolved solids. With the exception of the deepest sample from site 2 (middle) in August, the dissolved-oxygen content was at least 4 mg/l at sampling times. These profiles and the data in the table represent baseline information that may be used to monitor possible water-quality changes.

*Selected water-quality data, Sand Lake and Brentwood subdivision runoff water, 1967 to 1975*

| Parameters | Units | Sand Lake 1968 6/13 | 1968 9/3 | 1972* 3/27 | 1972* 6/27 | 1972* 8/23 | 1974 3/27 | 1975 2/5 | 1975 5/30 | 1975 10/7 | Brentwood subdivision runoff 1974 3/26 | 1975 4/6 | 1975 4/7 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Specific conductance | micromhos | 47 | 48 | 62† | 51† | 52† | 60 | 67 | 58 | 56 | 180 | 750 | 360 |
| Temperature | °C | 16.5 | 22.0 | - | - | - | 2.0 | 0.5 | 10.0 | 9.5 | 4.5 | 4.0 | 5.0 |
| Dissolved solids | mg/l | 23 | 24 | 37 | 31 | 31 | 29 | 40 | 30 | 30 | 93 | - | - |
| Total hardness (as $CaCO_3$) | mg/l | 12 | 13 | - | - | - | 15 | 23 | 20 | 19 | 22 | - | - |
| pH | units | 6.6 | 6.6 | - | - | - | 6.8 | 7.7 | 6.5 | 7.0 | 7.0 | 6.4 | 6.5 |
| Color | Pt-Co units | 0 | 10 | - | - | - | 5 | 10 | 4 | 5 | 100 | - | - |
| Dissolved silica ($SiO_2$) | mg/l | 0.1 | 0.1 | 0.3 | 0.3 | 0.4 | 0.1 | 0.7 | 0.2 | 0.1 | 2.6 | - | - |
| Dissolved calcium (Ca) | mg/l | 2.8 | 3.2 | 3.7 | 4.1 | 3.0 | 3.7 | 5.7 | 4.7 | 4.2 | 6.8 | 26 | 20 |
| Dissolved magnesium (Mg) | mg/l | 1.4 | 1.2 | 1.6 | 1.6 | 1.6 | 1.5 | 2.1 | 1.9 | 2.0 | 1.3 | - | - |
| Dissolved sodium (Na) | mg/l | 1.8 | 2.0 | 2.6 | 2.0 | 2.6 | 3.1 | 3.8 | 3.2 | 3.2 | 19 | 74 | 34 |
| Dissolved potassium (K) | mg/l | 1.3 | 1.7 | 1.6 | 1.3 | 1.6 | 2.2 | 2.1 | 1.7 | 1.7 | 7.8 | - | - |
| Bicarbonate ($HCO_3$) | mg/l | 8.0 | 6.0 | 12 | 10 | 11 | 10 | 22 | 11 | 15 | 30 | 10 | 17 |
| Carbonate ($CO_3$) | mg/l | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Dissolved sulfate ($SO_4$) | mg/l | 9.0 | 9.2 | 9.6 | 7.7 | 8.4 | 8.6 | 8.7 | 7.2 | 6.5 | 4.5 | - | - |
| Dissolved chloride (Cl) | mg/l | 2.8 | 2.9 | 2.9 | 3.0 | 3.0 | 4.1 | 5.3 | 5.2 | 4.4 | 33 | 40 | 74 |
| Dissolved nitrate (as N) | mg/l | 0.00 | 0.08 | 0.12† | 0.03† | 0.00† | 0.14** | 0.04** | 0.01** | 0.04** | 0.45 | - | - |
| Dissolved nitrite (as N) | mg/l | - | - | 0.00 | 0.00 | - | - | - | - | - | - | - | - |
| Dissolved orthophosphorus (as P) | mg/l | - | - | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.01 | 0.01 | 0.24 | - | - |
| Total phosphorus (as P) | mg/l | - | - | 0.01† | 0.00† | 0.01† | - | - | - | 0.01 | 0.74 | 0.37 | 0.31 |
| Total organic carbon | mg/l | - | - | - | - | - | 14 | - | 6.0 | - | 27 | - | - |
| Chlorophyll a, b | µg/l | - | - | - | - | - | - | - | - | 0 | - | - | - |
| Algal growth potential | mg/l | - | - | - | - | - | - | - | - | 1.2 | - | - | - |
| Total coliform | Colonies per 100 ml | - | - | 7 | 25 | - | - | - | - | - | - | - | - |
| Aluminum (Al) | µg/l | - | - | - | - | - | - | t100 | - | - | - | - | - |
| Arsenic (As) | µg/l | - | - | - | - | - | - | t0 | - | t0 | - | - | - |
| Boron (B) | µg/l | - | - | d21, t13 | t11 | d10 | - | - | t60 | - | - | - | - |
| Cadmium (Cd) | µg/l | - | - | d2 | d3 | d2 | - | t10 | - | t1 | - | t0.1 | t2 |
| Chromium (Cr) | µg/l | - | - | d3 | d3 | d4 | - | t0 | - | - | - | t30 | t50 |
| Copper (Cu) | µg/l | - | - | d12 | d20 | d32 | - | t130 | - | - | - | t85 | t110 |
| Iron (Fe) | µg/l | t40 | - | d60 | d49 | d15 | d80 | t60, d10 | - | t110, d60 | d700 | t20,000 | t33,000 |
| Lead (Pb) | µg/l | - | - | d3 | d4 | d3 | t<100 | t 100 | - | t5 | t600 | t900 | t,1000 |
| Manganese (Mn) | µg/l | - | - | d28 | d25 | d17 | d0 | t10, d10 | - | d20 | d90 | - | - |
| Selenium (Se) | µg/l | - | - | - | - | - | - | t0.0 | - | - | - | - | - |
| Silver (Ag) | µg/l | - | - | - | - | - | - | t-10 | - | - | - | - | - |
| Zinc (Zn) | µg/l | - | - | - | - | - | - | t10 | - | - | - | - | - |

† See profiles for graphic presentation of selected data.
* Mean concentrations calculated from 18 samples in March, 18 in June, and 15 in August.
** Nitrate values for 1974 and 1975 reflect nitrate plus nitrite as N.
‡ Analyses by Alaska Department of Health and Social Services.
d Dissolved.
t Total.




Concentration of Selected Chemical Constituents in Snowmelt Runoff from Brentwood Subdivision, 1975

Snowmelt water entering Brentwood Canal from the adjacent Brentwood subdivision has a dissolved-solids concentration 10 times as great as that in the main body of Sand Lake. The urban runoff also contains lead concentrations 100 times greater and iron 1,000 times greater than those of Sand Lake water. Lead concentrations exceed known values in any other surface or ground water in the Anchorage area, including water collected beneath landfills (Donaldson, Still, and Zenone, 1975; Zenone and Donaldson, 1974). Concentrations of several other metals may pose a threat to various aquatic life forms (Schroeder, 1965; Doudoroff and Katz, 1953; Pickering and Gast, 1972).

These data were collected during the initial snowmelt runoff flow in the street gutters of the Brentwood subdivision. The volume of snowmelt and rainfall runoff entering Brentwood Canal has not been measured, but it could vary greatly depending on amount, distribution, and intensity of precipitation.

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